

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS

1. An isolated and purified polynucleotide, or a variant, fragment or analog thereof, encoding a codeinone reductase enzyme from an alkaloid poppy plant.
2. A polynucleotide according to claim 1, selected from the group consisting of genomic DNA, cDNA, or synthetic DNA.
3. A polynucleotide according to claim 1 or claim 2, selected from the group consisting of:
 - (a) the polynucleotide sequences shown in FIGS 10 to 15;
 - (b) the polynucleotide sequences which hybridize under stringent conditions to the complementary sequences of (a); and
 - (c) polynucleotide sequences which are degenerate to polynucleotide sequences of (a) or (b).
4. A polynucleotide according to any one of the preceding claims, lacking the native leader sequences or any of the 5' or 3' untranslated regions of the polynucleotide.
5. A polynucleotide according to claim 4, wherein the native leader sequences or any of the 5' or 3' untranslated regions are replaced with exogenous control/regulatory sequences which regulate optimised/enhanced expression of the polynucleotide in an expression system.
6. A polynucleotide according to any one of the preceding claims which encodes codeinone reductase enzyme of *Papaver somniferum*.
7. A polynucleotide according to any one of claims 2 to 6, which is a synthetic polynucleotide comprising one or more codons preferred for expression in plant cells.
8. An isolated and purified polynucleotide which codes for prokaryotic or eukaryotic expression of a codeinone reductase enzyme from an alkaloid poppy plant, or a variant, analog or fragment thereof, wherein the polynucleotide is expressed in an environment selected from the group consisting of the extracellular environment, an intracellular membranous compartment, intracellular cytoplasmic compartment or combinations thereof.
9. A polynucleotide according to claim 8, comprising a nucleotide sequence which directs expression of the codeinone reductase enzyme with respect to a particular cellular compartment or the extracellular environment.

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10. An isolated and purified polynucleotide having a sequence which is complementary to all or part of the sequence of a polynucleotide according to any one of claims 1 to 9.
11. A recombinant DNA construct comprising the polynucleotide according to any 5 one of claims 1 to 10.
12. A DNA construct according to claim 11, which is a viral or plasmid vector.
13. A DNA construct according to claim 11 or claim 12, capable of directing prokaryotic or eukaryotic expression of the polynucleotide encoding a codeinone reductase enzyme.
- 10 14. A DNA construct according to any one of claims 11 to 13, comprising a promoter suitable to control the expression of the polynucleotide.
15. A DNA construct according to claim 14, wherein the promoter is endogenous.
16. A DNA construct according to claim 14, wherein the promoter is derived from nos, cauliflower mosaic virus or subterranean clover mosaic virus.
- 15 17. A DNA construct according to claim 12 wherein the plasmid is pCAL-c.
18. A DNA construct according to claim 12 wherein the plasmid is pGEM-T.
19. A DNA construct according to claim 12 wherein the plasmid is pFastBacI.
20. An isolated and purified codeinone reductase enzyme, being a product of prokaryotic or eukaryotic expression of the polynucleotide of any one of claims 1 to 10 or a DNA construct of any one of claims 11 to 19.
21. An enzyme according to claim 20, being a product of yeast cell expression.
22. An enzyme according to claim 20, being a product of bacterial cell expression.
23. An enzyme according to claim 20, being a product of animal cell expression.
24. An enzyme according to claim 23, being a product of insect cell expression.
- 25 25. An enzyme according to claim 20, being a product of plant cell expression.
26. An enzyme according to claim 25, wherein the plant cell is an alkaloid poppy plant cell.
27. An enzyme according to claim 26, wherein the alkaloid poppy is *Papaver somniferum*.
- 30 28. An enzyme according to any one of claims 20 to 27, which is a variant incorporating amino acid deletions, substitutions, additions or combinations thereof,

wherein the variant retains one or more of the biological properties of codeinone reductase enzyme.

29. A cell transformed or transfected with a polynucleotide according to any one of claims 1 to 10 or a DNA construct according to any one of claims 11 to 19.
- 5 30. A cell according to claim 29, which is a plant cell.
31. A cell according to claim 30, wherein the plant cell is derived from an alkaloid poppy plant.
32. A cell according to claim 31, wherein the poppy plant is *Papaver somniferum*.
33. A cell according to claim 29, which is a bacterial cell.
- 10 34. A cell according to claim 29, which is an animal cell.
35. A cell according to claim 29, which is a yeast cell.
36. A callus transformed or transfected with a polynucleotide according to any one of claims 1 to 10 or a DNA construct according to any one of claims 11 to 19.
37. A plant transformed or transfected with a polynucleotide according to any one of claims 1 to 10 or a DNA construct according to any one of claims 11 to 19, wherein the plant exhibits altered expression of the codeinone reductase enzyme.
- 15 38. A plant according to claim 37, wherein the altered expression is overexpression of the codeinone reductase enzyme.
39. A plant according to claim 37, wherein the altered expression is reduced expression of the codeinone reductase enzyme.
- 20 40. A plant according to any one of claims 37 to 39, which is an alkaloid poppy plant.
41. A plant according to claim 40, wherein the plant has a higher or different alkaloid content when compared to a plant which has not been so transformed or transfected.
- 25 42. A plant according to claim 40 or claim 41, wherein the alkaloid poppy plant is *Papaver somniferum*.
43. A method for preparing plants which overexpress a codeinone reductase enzyme, comprising transfecting or transforming a plant cell, a plant part or a plant, with the polynucleotide according to any one of claims 1 to 10 or a DNA construct according to 30 any one of claims 11 to 19.
44. A method according to claim 43, wherein the plant is an alkaloid poppy plant.

45. A method according to claim 44, wherein the poppy plant is *Papaver somniferum*.
46. A method of altering the yield or type of alkaloid in a plant comprising transforming or transfecting a plant cell, a plant part or a plant with a polynucleotide, or 5 a variant, analog or fragment thereof, encoding a codeinone reductase enzyme or with a polynucleotide which binds under stringent conditions to the polynucleotide encoding said enzyme.
47. A method of increasing the yield of alkaloid in a plant comprising transforming or transfecting a plant cell, a plant part or a plant with a polynucleotide, or a variant, 10 analog or fragment thereof, encoding a codeinone reductase enzyme wherein the enzyme is overexpressed in said plant.
48. A method of altering type or blend of alkaloid in a plant comprising transforming or transfecting a plant cell, a plant part or a plant with a polynucleotide or a variant, analog or fragment thereof, encoding a codeinone reductase enzyme or with a 15 polynucleotide which binds under stringent conditions to the polynucleotide encoding said enzyme.
49. A stand of stably reproducing alkaloid poppies transformed or transfected with a polynucleotide according to any one of claims 1 to 10 or a DNA construct according to any one of claims 11 to 19, having altered expression of the codeinone reductase 20 enzyme.
50. A stand of stably reproducing alkaloid poppies transformed or transfected with a polynucleotide according to any one of claims 1 to 10 or a DNA construct according to any one of claims 11 to 19, having a higher or different alkaloid content when compared to a plant which has not been so transformed or transfected.
- 25 51. A stand of stably reproducing alkaloid poppies according to claim 49 or claim 50, wherein the alkaloid poppy is *Papaver somniferum*.
52. Straw of stably reproducing poppies according to any one of claims 49 to 51, having a higher or different alkaloid content when compared to the straw obtained from an alkaloid poppy which has not been transformed or transfected.

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53. A concentrate of straw according to claim 52, having a higher or different alkaloid content when compared to the concentrate of straw obtained from an alkaloid poppy which has not been transformed or transfected.
54. An alkaloid when isolated from the straw according to any one of claims 49 to 52 or the concentrate according to claim 53.
55. An alkaloid according to claim 54, selected from the group consisting of morphine, codeine, oripavine and thebaine.
56. A method for the production of poppy plant alkaloids, comprising the steps of;
 - a) harvesting capsules of an alkaloid poppy plant transformed or transfected with a polynucleotide according to any one of claims 1 to 10 or a DNA construct according to any one of claims 11 to 19, to produce a straw where the poppy plant is such a plant that the straw has a higher or different alkaloid content when compared to the straw obtained from a poppy plant which has not been transformed or transfected.
 - b) chemically extracting the alkaloids from the straw.
- 15 57. A method for the production of poppy alkaloids, comprising the steps of;
 - a) collecting and drying the latex of the immature capsules of an alkaloid poppy plant transformed or transfected with a polynucleotide according to any one of claims 1 to 10 or a DNA construct according to any one of claims 11 to 19, to produce opium wherein the poppy plant is such a plant that the opium has a higher or different alkaloid content when compared to the opium obtained from a poppy plant which has not been transformed or transfected.
 - b) chemically extracting the alkaloids from the opium.
58. A method according to claim 56 or claim 57, wherein the alkaloid is selected from the group consisting of morphine, codeine, oripavine and thebaine.
- 25 59. The polynucleotide sequence encoding codeinone reductase comprised in microbial deposit DSM 12737.
60. The polynucleotide sequence encoding codeinone reductase comprised in microbial deposit DSM 12738.
61. The polynucleotide sequence encoding codeinone reductase comprised in
- 30 microbial deposit DSM 12739.

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62. The polynucleotide sequence encoding codeinone reductase comprised in microbial deposit DSM 12740.